Recommendation of the FCC Disability Advisory Committee
RTT Implementations with Refreshable Braille Displays
Adopted October 16, 2017

Question addressed herein: What are the technical and practical challenges of supporting compatibility of real-time text with refreshable Braille displays and similar assistive technologies?

1. WHEREAS the Federal Communications Commission ("FCC" or "the Commission") Report and Order on Real-Time Text[1] does not place requirements on manufacturers of real-time text (RTT) technologies or telecommunications carriers to ensure compatibility of RTT implementations with refreshable Braille displays and similar assistive technologies; and

2. WHEREAS the Technology Transitions Subcommittee has been asked to explore the technical and practical challenges of supporting compatibility of RTT implementations with refreshable Braille displays and similar assistive technologies; and

3. WHEREAS the Technology Transitions Subcommittee has gathered information from DeafBlind expert presenters, who shared the following challenges that DeafBlind individuals face with using RTT communications for consideration:

a. Real-time text is text transmitted instantly while it is being typed or created. The recipient can immediately read the sender's text as it is written, without waiting - each text character appears on the receiving device at roughly the same time it is typed on the sending device;

b. Braille includes short form words and characters that are modified based on the position in a word;

c. A user of refreshable Braille may see different words as each letter is typed depending on the Braille translation table[2] in use along with the method of implementation for Braille translation, potentially causing confusion and frustration;

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[1]*Transition from TTY to Real-Time Text Technology, et al.,* Report and Order, Further Notice of Proposed Rulemaking, FCC 16-169, CG Docket Nod. 16-145 & 15-178 (rel. December 16, 2016).

[2]A Braille translation table is used by the translation engine of an assistive technology to represent content using the selected braille code. Braille can be represented using a number of different systems. For example, the Computer Braille Code uses a one-to-one mapping between print and Braille characters so that an exact rendering of the print content can be achieved. This system has the advantage of eliminating ambiguities in translation and is often required for inputting complex content such as email addresses and web URLs accurately into systems that store content as print text. The Literary Braille Code is the common code used for literary and nontechnical content. This code is further divided into contracted and uncontracted Braille. Contracted Braille uses short forms, abbreviations and special symbols to represent words or groups of characters in order to save space. Literary Braille codes can vary between languages and regions. English-speaking countries currently standardize on the Unified English Braille (UEB) code, however prior to this each country had their own braille code such as the English Braille American Edition (EBAE) code which was used in the United States prior to the adoption of UEB in 2016. Most assistive technologies currently support these older Braille codes to accommodate users who have not yet made the transition. A Braille translation table contains the rules to be used by the translation engine for the Braille code in use to specify how the translated text should be interpreted for Braille input or displayed for Braille output. This

i. Depending on where the character falls in a word or how it is modified by an earlier character, the Braille character may have different meanings. For example, the character for letter "w" alone means the word "will." Until you put in a space to indicate a new word, the user would not know if the "w" in question is for the word "will" or the first letter in the word "won't," rendering character by character displays unintelligible and perhaps causing the user to misunderstand the message;

d. Braille translation issues are under the user's control on most platforms;

e. The user often has the choice to have content displayed in either computer or literary Braille, and they can further choose to have the literary Braille contracted or uncontracted;

f. This requires the reader to be familiar with other translation tables in order to switch to them;

g. Some type of notification that the other party is typing and has stopped typing will enable the user to know whether the word is complete;

h. Refreshable Braille devices utilize a single line display;

i. Both parties are unable to use Braille characters on the single line display at the same time. Because if text from the remote side arrives while the DeafBlind individual is still typing on the display, it could interrupt the typing and cause confusion with intermixed text;

j. The user would need to control which area of the application to focus and monitor, meaning whether the user wishes to monitor the message they are composing or a particular incoming message as it is received;

k. An option for the user to enable turn taking protocol may eliminate such confusion;

l. There would need to be software support for such turn-taking ability;

m. Introducing technical implementations to delay the transmissions of characters may defeat the purpose of RTT and its asynchronous nature;

n. Adjusting the Braille reading speed in settings is one possibility;

o. The ability to jump back to the most recent message would further lessen these challenges;

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allows a single translation engine to be used for supporting an unlimited number of Braille codes. *See* Braille Authority of North America, *Unified English Braille*, http://brailleauthority.org/ueb.html; *see also* Holbrook, M. C., & MacCuspie, P. A. (2010). The Unified English Braille Code: Examination by science, mathematics, and computer science technical expert Braille readers, *Journal of Visual Impairment & Blindness*, *104*(9), 533, https://search.proquest.com/docview/751286869?pq-origsite=gscholar; *see also* Cryer, H., Home, S., and Osborne, P. (2011). Unified English Braille (UEB) Implementation: State of the Nations. RNIB Centre for Accessible Information, Birmingham: Research report #14, https://www.rnib.org.uk/sites/default/files/2011_04_UEB_Implementation.doc

p. DeafBlind users need to use both hands to input words and to read words, meaning there needs to be some method of identifying the writer when reviewing what has been written and then responding in a multi-party conversation; and

q. Multiple accessibility features are now available on most smart phone operating systems that are expected to be capable of utilizing RTT. Apple iOS, Google Android, and Windows 10 all have built-in accessibility capabilities under the phone's settings that allow for changing contrast, font size, and color palettes that are helpful for individuals with low vision.[3]

4. WHEREAS the Technology Transition Subcommittee has developed use cases for RTT calls that involve refreshable Braille to illustrate the above (see Appendix A); and

5.WHEREAS while the Subcommittee has identified the needs above, more complete engagement is needed for developing best practices.

1. RECOMMENDED that the Disability Advisory Committee (DAC), by way of the Technology Transitions Committee, undertake an in-depth study for developing best practices and host a roundtable with appropriate stakeholders for a full dialogue on the following open questions for follow-up recommendations to be submitted at a later date; and

2. RECOMMENDED further, that the following open questions be explored:

1. What are the functional user needs for RTT?
    a. DeafBlind users?
        i. How consumers communicate over RTT through consumer participation, using two different approaches for comparison.
            1. Using half duplex, the way TTY operates, where one end of the call says go ahead to indicate they are done (turn taking).
                a. How can users have control over turn taking in RTT?
            2. Allow for the DeafBlind person to read and type simultaneously.
    b. Low vision users?
2. What technical limitations exist and how can they be addressed?

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[3]A large proportion of DeafBlind individuals who possess Usher Syndrome have unique needs. *See* Bailey, I. L. & Hall, A(1990), *Visual impairment: An overview*, American Foundation for the Blind, https://books.google.com/books?hl=en&lr=&id=0DcZ3G1iD9MC&oi=fnd&pg=PA1&dq=Retinitis+Pigmentosa+color+contrast+magnification&ots=rVQXKzbtkk&sig=seMsZOHBqpj_wqyRs_oMOpuobRA#v=onepage&q&f=false. On the visual spectrum, Usher is comparable to Retinitis Pigmentosa (RP), which is a common genetic degenerative eye condition that becomes more severe as an individual gets older. Early on, the individual loses peripheral vision, and as RP progresses, vision loss moves more into the central field. Issues with glare and difficulty distinguishing colors are also common as the condition progresses. For this reason, for this population, alteration of font size is not as critical as control over contrast and colors; in fact, enlarging fonts may cause difficulties as the field of vision decreases, making it necessary to scan more frequently when font size is enlarged. Also, the ability to change contrast is necessary to reduce glare. Avoiding similar colors, such as blue and black text together, is also helpful. *See* WebAIM (2013), *Low Vision*, http://webaim.org/articles/visual/lowvision; *see also* W3C (2016), *Types of Low Vision*, https://www.w3.org/WAI/GL/low-vision-a11y-tf/wiki/Types_of_Low_Vision.

   a. Examples: equipment compatibility, drive and operating system disparities
   b. Could the challenges stifle innovation?
3. What commonly used assistive technology should be used when conducting testing for operating systems?
   1. Pair a variety of equipment and pair with the most popular wireless phones for the DeafBlind community for testing. This should be done in the lab, and funds should be allocated as appropriate.
   2. Enlist users of devices commonly used by DeafBlind consumers and ask them to test.

3. RECOMMENDED further, that the following stakeholders be represented at the roundtable:

1. Platform manufacturers
2. Assistive technology vendors
   a. Native implementations
   b. Third-party applications
   c. Screen reader manufacturers
   d. Braille display manufacturers
3. Phone manufacturers
4. Phone carriers
5. Operating system vendors
6. DeafBlind users
7. Standards bodies
   a. Device specifications
   b. Service descriptions
8. Academic institutions with accessibility research expertise

APPENDIX A: Use Cases

How to read a use case

Use cases describe **what** the user experiences, not how this is or should be implemented in technology. To this end, use cases are kept technology-neutral to the greatest extent possible, and specifically do not make assumptions about the respective responsibilities of the application, screen readers, Braille drivers, and refreshable Braille displays.

Each use case follows a common pattern. The short description section states what the interaction is all about. The actors section states who is present in a call, and what type of disability they have, if any, and what their preferred input/output methods are. The pre-conditions state what, at a minimum, needs to be true before a call can succeed, and what user settings and preferences are applicable. The post-condition states what the expected outcome is. The normal flow explains the most typical call flow scenario for the given use case, step by step. The alternate flow explains what must be changed if there is a slight modification to the use case that, overall, does not materially change the nature of the conversation (for example, if one person mixes voice and RTT). Exceptions describe what happens if the call cannot be completed successfully.

The use cases refer to ambiguity in several places. This reflects the summary of the discussion above, which states that contracted forms of Braille are not unambiguous until at a minimum a word has been completed. Specifically, the phrase "once the typed text is unambiguous" refers to the portion of the text of which the meaning will not be affected anymore by subsequently typed characters.

Use cases covered

1. Turn-Based RTT Communication between a DeafBlind Braille User and a Sighted User
2. RTT Communication between a DeafBlind Braille User and a Sighted User with Simultaneous Typing
3. RTT Communication for a DeafBlind Low-Vision User who Uses Screen Magnification or Contrast Enhancements and a Sighted User

1. Turn-Based RTT Communication between a DeafBlind Braille User and a Sighted User

Short Description

This use case addresses RTT communication between a user who is DeafBlind and uses a refreshable Braille display to read and type text, and a sighted user who types RTT on a touchscreen or physical keyboard. The DeafBlind user prefers turn-based communication where only one person types at a time.

The DeafBlind user may or may not use a form of Braille where a word can be identified unambiguously only after a space has been typed to mark the word boundary.

Actors

Alice is the DeafBlind person using a refreshable Braille display.

Bob is the sighted person using a touchscreen or physical keyboard.

Pre-Conditions

Both users have devices that support RTT as per the FCC rules.

Both users subscribe to a phone plan that supports RTT calls on their chosen devices as per the FCC rules.

Alice has her refreshable Braille display paired with her device.

Alice has configured her RTT settings to indicate that she prefers turn-based typing.

Alice has configured her screen reader/refreshable Braille display settings according to her preferences for reading speed, computer or literary Braille, and uncontracted or contracted Braille.

Alice’s RTT settings are to send text in real time.

Bob’s RTT settings are to send text in real time.

Post Conditions

The users have completed a call where they used their devices’ RTT functionality, optionally intermixed with voice, to communicate with each other.

Normal Flow

1. Alice uses her refreshable Braille display to dial Bob’s 10-digit number.
2. Bob answers the call as an RTT call.

3. Bob's device receives Alice's preference for turn-based typing.
4. Bob's device switches into single-screen mode and notifies him through a visual indicator that turn-based typing is active.
5. Bob types RTT to answer the call and types GA to signal the end of his turn: *Hello GA.* His phone sends the typed text in real time to Alice.
6. Alice's phone receives Bob's RTT.
7. Alice's refreshable Braille displays Bob's text according to her preferences for reading speed and Braille output.
8. When Alice encounters the *GA* from Bob, she starts typing back on her refreshable Braille display. She marks the end of her turn by typing *GA.* Alice's phone sends the text in real time, once the typed Braille text is unambiguous.
9. Bob's phone receives Alice's RTT
10. Bob's phone display shows Alice's RTT as it is being transmitted in real-time.
11. When Bob encounters the *GA* from Alice, he starts typing back. Alice and Bob continue taking turns until one or both wish to end the call.
12. Alice and/or Bob hang up.

Alternative Flows

Alternative Flow #1

Bob makes a phone call to Alice.

Step 1 changes as follows:

Bob uses his touchscreen or physical keyboard to dial Alice's 10-digit number.

Step 2 changes as follows:

Alice answers the call as an RTT call.

Alternative Flow #2

Alice uses her voice to communicate with Bob.

Step 8 changes as follows:

When Alice encounters the *GA* from Bob, she starts speaking back through her phone's microphone.

Step 9 changes as follows:

Bob's phone receives Alice's voice.

Step 10 changes as follows:

Bob’s phone speaker outputs Alice’s voice.

Step 11 changes as follows:

When Bob hears that Alice stops speaking, he starts typing back. Alice and Bob continue taking turns until one or both wish to end the call.

Exceptions

Bob is unable or unwilling to accept an RTT call.

Step 2 changes as follows:

Bob rejects the call. Alice receives a rejection notification on her refreshable Braille display.

2. RTT Communication between a DeafBlind Braille User and a Sighted User with Simultaneous Typing

Short Description

This use case addresses RTT communication between a user who is DeafBlind and uses a refreshable Braille display to read and type text, and a sighted user who types RTT on a touchscreen or physical keyboard. The DeafBlind user prefers simultaneous communication where both users can type at the same time.

The DeafBlind user may or may not use a form of Braille where a word can be identified unambiguously only after a space has been typed to mark the word boundary.

(Note – this use case is based on emails where it was pointed out that some users may prefer it this way.)

Actors

Alice is the DeafBlind person using a refreshable Braille display.

Bob is the sighted person using a touchscreen or physical keyboard.

Pre-Conditions

Both users have devices that support RTT as per the FCC rules.

Both users subscribe to a phone plan that supports RTT calls on their chosen devices as per the FCC rules.

Alice has her refreshable Braille display paired with her device.

Alice has **not** configured her RTT settings to indicate that she prefers turn-based typing.

Alice has configured her screen reader/refreshable Braille display settings according to her preferences for reading speed, computer or literary Braille, and uncontracted or contracted Braille.

Alice's RTT settings are to send text in real time.

Bob's RTT settings are to send text in real time.

Post Conditions

The users have completed a call where they used their devices' RTT functionality, optionally intermixed with voice, to communicate with each other.

Normal Flow

1. Alice uses her refreshable Braille display to dial Bob's 10-digit number.
2. Bob answers the call as an RTT call.
3. Bob types RTT to answer the call and types *Hello*. His phone sends the typed text in real time to Alice.
4. Alice's phone receives Bob's RTT.
5. Alice's refreshable Braille display indicates that Bob is typing.
6. Alice switches her display to read Bob's text. It displays Bob's text according to her preferences for reading speed and Braille output. Alice uses navigation shortcuts to display specific parts of Bob's message, pause or resume live updates, or jump to the end of Bob's message.
7. When Alice wishes to respond, she switches her display to typing. She starts typing back on her refreshable Braille display. Alice's phone sends the text in real time, once the typed Braille text is unambiguous.
8. Bob's phone receives Alice's RTT
9. Bob's phone display shows Alice's RTT as it is being transmitted in real-time.
10. When Bob wishes to respond, he starts typing back. His phone sends the typed text in real time to Alice.
11. While Alice is typing, her phone receives Bob's RTT. Her refreshable Braille display indicates that Bob has typed new text, but otherwise does nothing to interrupt Alice's typing.
12. Alice continues typing until she wishes to read Bob's text.
13. Alice switches her display to reading Bob's text. Using navigation shortcuts, she jumps immediately past the last-read part of Bob's text. She reads Bob's text with the same actions as in Step 6.
14. Alice and Bob continue the conversation until one or both wish to end the call.
15. Alice and/or Bob hang up.

Alternative Flows

Alternative Flow #1

Bob makes a phone call to Alice.

Step 1 changes as follows:

Bob uses his touchscreen or physical keyboard to dial Alice’s 10-digit number.

Step 2 changes as follows:

Alice answers the call as an RTT call.

Alternative Flow #2

Alice uses her voice to communicate with Bob.

Step 7 changes as follows:

When Alice wishes to respond, she starts speaking back through her phone’s microphone.

Step 8 changes as follows:

Bob’s phone receives Alice’s voice.

Step 9 changes as follows:

Bob’s phone speaker outputs Alice’s voice.

Step 10 changes as follows:

Bob starts typing back. His phone sends the typed text in real time to Alice.

Step 11 changes as follows:

While Alice is speaking, her phone receives Bob’s RTT. Her refreshable Braille display indicates that Bob has typed new text.

Step 12 is deleted.

Exceptions

Bob is unable or unwilling to accept an RTT call.

Step 2 changes as follows:

Bob rejects the call. Alice receives a rejection notification on her refreshable Braille display.

3. RTT Communication for a DeafBlind Low-Vision User who Uses Screen Magnification or Contrast Enhancements and a Sighted User

Short Description

This use case addresses RTT communication between a user who is DeafBlind or deaf with low vision and uses screen magnification or contrast enhancements to read and type text, and a sighted user who types RTT on a touchscreen or physical keyboard. The low vision user prefers simultaneous communication where both users can type at the same time.

Actors

Alice is the DeafBlind or deaf person using screen magnification on a touch screen and optionally a physical keyboard.

Bob is the sighted person using a touchscreen or physical keyboard.

Pre-Conditions

Both users have devices that support RTT as per the FCC rules.

Both users subscribe to a phone plan that supports RTT calls on their chosen devices as per the FCC rules.

Alice has **not** configured her RTT settings to indicate that she prefers turn-based typing.

Alice has configured her default font typeface, size, contrast and font/background colors according to her preferences.

Alice has her screen magnification enabled in the device's settings.

Alice's RTT settings are to send text in real time.

Bob's RTT settings are to send text in real time.

Post Conditions

The users have completed a call where they used their devices' RTT functionality, optionally intermixed with voice, to communicate with each other.

Normal Flow

1. Alice uses the phone's dial pad or her physical keyboard to dial Bob's 10-digit number. She used screen magnification to zoom in to touch the correct digits.
2. Bob answers the call as an RTT call.
3. Bob types RTT to answer the call and types: *Hello.* His phone sends the typed text in real time to Alice.

4. Alice's phone receives Bob's RTT.
5. Alice's phone displays the RTT on her screen in real time, using the font and color settings according to the preconditions. If the text goes past the bottom line on Alice's display, it scrolls up to make space for a new line.
6. Alice uses the screen magnifier to zoom into the text to read it. While zooming, the RTT text on her display *does not scroll as Bob types*, so as to avoid the text from jumping out of the zoom window. Alice is able to scroll back and forth on her display manually as needed while reading.
7. When Alice wishes to respond, she starts typing back on the RTT entry widget on her touchscreen display or on her physical keyboard. Alice uses her zoom functionality as needed while entering text. Alice's phone sends the text in real time as she types.
8. Simultaneously, her display adds any new text that Bob types.
9. Bob's phone receives Alice's RTT
10. Bob's phone display shows Alice's RTT as it is being transmitted in real-time.
11. Alice and Bob continue the conversation until one or both wish to end the call.
12. Alice and/or Bob hang up.

Alternative Flows

Alternative Flow #1

Alice does not use screen magnification, but does use the device's built-in accessibility features to configure font size, contrast and colors.

Step 6 changes as follows:

Alice reads the text as determined by her configuration options. Alice is able to scroll back and forth on her display manually as needed while reading.

Step 7 changes as follows:

When Alice wishes to respond, she starts typing back on the RTT entry widget on her touchscreen display or on her physical keyboard; the entered text appears as determined by her configuration settings. Alice's phone sends the text in real time as she types.

Alternative Flow #2

Bob makes a phone call to Alice.

Step 1 changes as follows:

Bob uses his touchscreen or physical keyboard to dial Alice's 10-digit number.

Step 2 changes as follows:

Alice answers the call as an RTT call.

Alternative Flow #3

Alice uses her voice to communicate with Bob.

Step 7 changes as follows:

When Alice is ready to respond, she starts speaking back through her phone’s microphone.

Step 9 changes as follows:

Bob’s phone receives Alice’s voice.

Step 10 changes as follows:

Bob’s phone speaker outputs Alice’s voice.

Step 11 changes as follows:

When Bob hears that Alice stops speaking, he starts typing back. Alice and Bob continue taking turns until one or both wish to end the call.

Exceptions

Bob is unable or unwilling to accept an RTT call.

Step 2 changes as follows:

Bob rejects the call. Alice receives a rejection notification on her display.